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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/625,007	07/23/2003	Kyoung-woo Lee	SAM-0313CIP	8434

7590 11/15/2005
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EXAMINER

NGUYEN, HA T

ART UNIT	PAPER NUMBER
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2812

DATE MAILED: 11/15/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

HA

Office Action Summary	Application No. 10/625,007	Applicant(s) LEE ET AL.	
	Examiner Ha T. Nguyen	Art Unit 2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 September 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-52 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-52 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>9-1-5. 9-6-05</u> | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

1. Applicant's Amendment and Response to the Office Action mailed 6-2-5 has been entered and made of record.

Claim Rejections - 35 USC, § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103 and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1-10, 13, 16, 18-28, 31, 34, 36-43, 45, 48, and 50-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsu et al. (USPN 6461955, hereinafter "Tsu") in view of Aoi (USPN 6387824) and Lee et al. (USPN 6171951, hereinafter "Lee").

Referring to Figs. 2A-2G and related text, Tsu discloses [Re claim 1] a method of fabricating dual damascene interconnections, the method comprising: (a) forming on a substrate 100 a hybrid dielectric layer 106, 108; (b) forming a via 112 in the dielectric layer; (c) filling the via with a carbon-free inorganic filler 114; (e) partially etching the inorganic filler filling the via and the dielectric layer to form a trench, which is connected to the via and in which interconnections will be formed (see Fig. 2E); (f) removing the inorganic filler remaining in the via; and (g) completing interconnections by filling the trench and the via with interconnection

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material (See Fee 2F-2G); [Re claims 2, 4-5, 10, 13, 21-23, and 31] a method of fabricating dual damascene interconnections, the method comprising: (a) forming an organo silicate glass layer on a substrate; (b) forming a via in the organo silicate glass layer; (c) filling the via with an HSQ-based filler (see col. 3, lines 29-39); (e) partially etching the HSQ -based filler filling the via and the organo silicate glass layer to form a trench, which is connected to the via and in which interconnections will be formed; (f) removing the HSQ -based filler remaining in the via; and (g) completing interconnections by filling the trench and the via with an interconnection material, as shown above. But it fails to disclose expressly the use of a hybrid dielectric, an organo silicate glass and the value of its dielectric constant, the etching of the filler using HF, the use of CVD to deposit the hybrid dielectric, the processing the surface of the filler using plasma and the details about the plasma. However, the missing limitations are well known in the art because Aoi discloses most of these features (See embodiment 3) and Lee discloses plasma treating a low k dielectric layer to densify the layer preventing damage caused by subsequent process (see col. 3, lines 24-37). Besides HF is well known to be used for etching silicon oxide based material. A person of ordinary skill is motivated to modify Tsu with Aoi and Lee to obtain device of low capacitance made in a more reliable manner.

[Re claim 39] Arguments used for the rejections of claims 21-23 also apply. Besides, Lee also discloses forming a hard mask 312 of silicon nitride or silicon oxynitride, which are also ARC material, on the plasma treated layer 310 (see Fig. 2B-2C).

[Re claims 3, 6-8, 24-27, and 40-43] Tsu also discloses wherein the etch stop layer is formed of at least one of SiC, SiN, and SiCN; before step (b), forming a capping layer on the hybrid dielectric layer having a dielectric constant of 3.3 or less; wherein in step (b), a via is formed in the capping layer and the dielectric layer; wherein the capping layer is formed of an anti-reflective material; wherein the capping layer is formed of at least one of SiO₂, SiOF, SiON, SiC, SiN and SiCN (see Figs. 2A-2C and col. 2, line 45-col. 3, line 14);

[Re claims 16, 34, and 48] wherein step (d) includes: forming a photoresist pattern 120 on the inorganic filler to define the trench; forming the trench by dry etching using the photoresist pattern as an etch mask such that an etch ratio of the inorganic filler to the dielectric layer is 4:1 or lower; and removing the photoresist pattern; and

[Re claims 18-19, 36-37, and 50-51] wherein step (f) comprises wet etching such that an etch ratio of the inorganic filler to the dielectric layer is 20:1 or higher. (see Fig. 2D-2E and col. 3, lines 29-38); [Re claims 20, 38, and 52] wherein in step (g), the interconnection is a copper interconnection (see col. 4, lines 13-17) .

[Re claims 9 and 28] Aoi also discloses forming a photoresist pattern on the dielectric layer to define the via; and forming the via exposing the etch stop layer by dry etching the dielectric layer using the photoresist pattern as an etch mask (see Fig. 3(b)).

[Re claim 45] Arguments used for the rejections of claims 13 and 31 also apply.

Therefore, at the time of the invention, it would have been obvious to combine Tsu with Aoi and Lee to obtain the invention as specified in claims 1-10, 13, 16, 18-28, 31, 34, 36-43, 45, 48, and 50-52.

4. Claims 17, 35, and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable Tsu in view of Aoi and Lee, as applied above, and further in view of Robinson et al. (USPN 4201579, hereinafter "Robinson").

The combined teaching of Tsu, Aoi and Lee discloses substantially the limitations of claims 17, 35, and 49, as shown above.

But it fails to disclose expressly wherein the dry etching uses C_xF_y or $C_xH_yF_z$ as a main etching gas, and removing the photoresist pattern uses an H_2 -based plasma..

However, the missing limitation is well known in the art because Robinson discloses the use of H_2 plasma to remove photoresist (See col. , lines). Besides, the examiner takes Official Notice that C_xF_y or $C_xH_yF_z$ is conventional dry etchant for silicon oxide-based material.

A person of ordinary skill is motivated to modify Tsu, Aoi and Lee with Robinson to obtain clean device with no undesirable oxidation.

Therefore, at the time of the invention, it would have been obvious to combine Tsu, Aoi and Lee Aoi with Robinson to obtain the invention as specified in claims 17, 35, and 49.

5. Claims 11-12, 14-15, 29-30, 32-33, 44, and 46-47 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsu in view of the applied references, as applied above, and further in view of Lui (USPN 6391761).

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The combined teaching of Tsu and the applied references discloses substantially the limitations of claims 11-12, 14-15, 29-30, 32-33, 44, and 46-47, as shown above.

But it fails to disclose expressly the use of an organic antireflective layer under a photoresist layer.

However, this feature is well known in the art because Lui discloses the use of an organic antireflective layer 85 (See par. bridging cols. 4-5). The combined teaching of Tsu, Aoi, Lee and Lui does not disclose the thickness of the antireflective layer or the inclusion in the filler of a light absorption material and/or a dissolution inhibitor for a photoresist developing solution. However, it would have been obvious for an ordinary artisan to select an appropriate thickness to effectively achieve the desired objective and to include in the filler a dissolution inhibitor for a photoresist developing solution to prevent damage of the filler when the photoresist is developed.

A person of ordinary skill is motivated to modify Tsu and the applied references with Lui to obtain better resolution.

Therefore, at the time of the invention, it would have been obvious to combine Tsu and the applied references with Lui to obtain the invention as specified in claims 11-12, 14-15, 29-30, 32-33, 44, and 46-47.

Response to Amendment

6. In view of Applicants' amendment to the claims, the objection to claim 19, for informality, has been withdrawn.

In view of arguments and the amendment to the claims, the rejections of claims 1-38 under 35 U.S.C. 103, as stated in the immediately preceding Office Action, have been withdrawn.

Applicant's arguments with regard to the rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that the combined teaching of Tsu with the applied references does not teach plasma treating the surface of the filler. The examiner disagreed, even though Lee does not expressly disclose plasma treating the surface of the low k filler however Lee discloses the benefits of plasma treating an exposed surface of a low k dielectric at least to prevent damage caused by subsequent processing, the examiner considers this benefit to be a teaching applicable

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to exposed surface of a low k dielectric susceptible to damage caused by a subsequent process; the damage would results in problem with accurate control of feature dimensions. An ordinary artisan would have been motivated to combine Lee with Tsu to have better control of feature dimensions. In the combined teaching of Tsu with the applied references the surface of the filler is treated with plasma then the etching of the plasma treated filler would give better control of thickness to be etched resulting in more accurate trench width and depth.

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for response to this final action is set to expire THREE MONTHS from the date of this action. In the event a first response is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event will the statutory period for response expire later than SIX MONTHS from the date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha T. Nguyen whose telephone number is (571) 272-1678. The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt, can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR

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system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Ha Nguyen

Primary Examiner

11- 7 - 05